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Effects of bush clearing and soil cultivation on the invertebrate fauna of a forest soil in the humid tropics

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With 7 figures

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1. Introduction

Agriculture in the humid tropics is entering a period of transition during which increasing acreages are being developed using modern agricultural techniques in land, crop and pest management. A knowledge of the environmental impact of such activities is important for rational long-term planning and a joint project was developed by the Centre for Overseas Pest Research and the International Institute of Tropical Agriculture (IITA, Ibadan, Nigeria) to investigate the effects of bush clearing and soil cultivation and crop protection using DDT on a forest soil ecosystem, with particular reference to potential disruption of biological activity and consequent effects on soil fertility (PERFECT et al. in prep.).

A number of ecological studies have been undertaken on soil invertebrates in the humid tropics (DAMMERMAN 1925; WILLIAMS 1941; BECK 1962; MALDAGUE & HILGER 1963; TOYE 1967; MADGE 1969; FITTKAU & KLINGE 1973) though only the work by LASEBIKAN (1975) is directly concerned with the impact of agricultural practices. The present paper reports the responses of the soil fauna to the processes of clearing and cultivation in the absence of pesticide treatment. Further papers will consider pesticide effects on invertebrate populations.

2. Materials and methods

2.1. Experimental design

Twelve plots each 12 × 24 m were established in a 3 × 4 randomised complete block design in an area of 5 to 8 years forest regrowth. Three plots were left as forest regrowth and are subsequently referred to as bush plots. The remaining nine plots were cleared and cultivated with cowpea, *Vigna unguiculata* (L.) WALP, in each of two annual growing seasons during 1973 and 1974. Three plots received ten weekly applications of DDT during all growing seasons apart from the first season in 1973; three plots received DDT applications at the same rate in the second growing seasons only of

both years and three plots remained untreated. In this paper, comparisons are restricted to the bush and cultivated, untreated treatments. Further details of the experimental design, habitat description and climatic data are given by PERFECT et al. (in prep.).

2.2. Sampling methods

Surface active fauna was sampled by means of pitfall traps. During the first growing season of 1973 (season 73/1) 800 ml plastic beakers 100 mm in diameter were used. These were placed in the ground such that the lip was level with the soil surface and filled to a depth of 20–30 mm with aqueous picric acid to act as a killing and preserving fluid. The traps were later improved by suspending them in open-ended plastic pipes sunk vertically into the ground to minimise soil disturbance when removing the traps for emptying. Flooding and loss of specimens during rainfall were prevented by providing gauze covered drainage holes on the sides of the traps. To prevent evaporation of killing fluid and discoloration of soft-bodied specimens picric acid was replaced by 40% ethylene glycol containing 1% Resiguard, a bacteriostat. An illustration of this trap is given by McNUTT (1976).

During 1973, five pitfall traps in each plot were run at fortnightly intervals for periods of four days. To improve the estimates of activity for animal groups caught in low numbers traps were operated continuously during 1974, being emptied twice a week. Traps in cultivated plots were located midway between rows of cowpea plants in positions determined by random numbers. Those in the bush plots were placed in equivalent positions within the plot, herb growth and litter in a 300 mm radius around the trap being cleared to provide similar trapping conditions.

Microarthropods were sampled using a stainless steel corer with an internal diameter of 50 mm and a depth of 150 mm (PERFECT et al. in prep.). Three aluminium sleeves, each 50 mm long, were inserted into the corer so that the cores could be divided into three equal sections. Extraction of microarthropods from the cores was accomplished using a modified McFadyen high gradient multiple funnel apparatus (EDWARDS and FLETCHER 1971) where the temperature above the cores was gradually raised from ambient (around 30 °C) to 60 °C over a five day period. The first microarthropod samples were taken at the site in February 1973 prior to clearing the areas designated for cultivation. On this occasion the site was divided into four equal sized areas and four cores taken from each, the cores being extracted for the 0–50 mm, 50–100 mm and 100–150 mm horizons. The small number of cores taken was due to the limited extraction capacity at this time and since the majority of the fauna was located in the top 50 mm subsequent sampling was limited to this horizon until additional facilities became available in September. After clearing and before cultivation in March four cores were taken from each of the twelve plots. Planting took place in late April after which fortnightly samples of ten cores per plot were taken until the end of the first growing season and monthly thereafter until January 1974. All samples taken from the beginning of September 1973 were extracted for both the 0–50 mm and 50–100 mm horizons. In 1974 sampling frequency was reduced to coincide with major agronomic events such that cores were taken before ploughing in March, and at the beginning and end of each growing season.

Earthworm activity was monitored by determination of daily surface cast production per unit area of the two major cast types, attributed by MADGE (1969) to *Hyperiodrilus africanus* BEDDARD and *Eudrilus eugeniae* (KINBERG). The former produces discrete, turret-shaped casts whilst those of the latter are rather loose, granular mounds. These categories were retained throughout the work, though it is possible that casts of other related species were included in the counts. Assessment of casting activity involved the removal of all casts from the sampling sites and then the counting and collection of fresh casts after 24 hours. Estimates of casting activity for season 73/1 are based on counts from a single inter-row space per plot measuring 0.75×22 m in cultivated plots. In bush plots a smaller area of 0.60×4.0 m was used because of the high cast density. From season 73/2 the sampling regime was altered to take better account of intra-plot variation by the use of ten randomly selected sites, each 0.55×1.0 m in cultivated plots and 0.55×0.6 m in bush plots.

Qualitative data on termites and other mesofauna were obtained by hand sorting of soil from 0.1 m^2 pits dug to the gravel layer, a depth of about 30 cm, ten randomly selected sites being excavated in each plot and the soil returned after sorting.

To obtain information on temperature fluctuation in bush and cultivated habitats data were collected at intervals throughout 1974 using a Grant continuous temperature recorder in adjacent bush and cultivated plots. Thermistor probes, shielded from direct insolation, were placed at the soil surface and 50 cm above and 10 cm below the surface. To obtain estimates of soil moisture content, soil samples were taken weekly from April to November during 1974. Ten samples were taken per plot to depths of 0–12 cm and 12–24 cm using a 2.5 cm diameter soil corer. Subsamples were weighed, dried overnight at 100 °C and reweighed.

The activity and population data were compared using analysis of variance, being transformed to $\log(n + 1)$ to overcome problems of skew distribution. Plot totals were used as replicates in all cases with two-way analysis (treatment versus time) for series of data. Where populations were sampled at different depths multiway analysis of variance was used. With the exception of earthworms and termites all the data were analysed at the family or subfamily level.

Table 1. Relative abundance of the surface active arthropods from all treatments during the first growing season (April to July 1973)

Group	Mean number trap ⁻¹ occasion ⁻¹	Group	Mean number trap ⁻¹ occasion ⁻¹
Arachnida		Insecta	
Acari	8.13	Lepidoptera larvae	0.43
Aranac	5.69	Hymenoptera-Formicidae	26.77
Opilionida	0.04	Hymenoptera-others	2.82
Chelonethi	0.16	Coleoptera Carabidae	0.14
Schizomida	0.02	Staphylinidae	0.76
Insecta		Scarabeidae	0.62
Thysanura	0.62	Chrysomelidae	0.28
Diplura	0.05	Elateridae	0.05
Gryllidae	3.23	Curculionidae	0.11
Acrididae	0.12	Scolytidae	0.88
Orthoptera-others	0.06	Pselaphidae	0.53
Blattidae	0.03	others	2.21
Dermaptera	0.05	larvae	0.89
Isoptera	0.07	Thysanoptera	1.38
Psocoptera	0.20	Myriapoda	
Heteroptera	0.74	Symphyla	0.01
Homoptera	1.45	Diplopoda	0.83
Diptera larvae	1.46	Chilopoda	0.08
adults	2.94	Crustacea	
		Isopoda	0.23

(* n = 45, ** n = 9)

3. Results

3.1. Surface active fauna

A wide range of animals was recorded in pitfall traps (Table 1) though only crickets worker ants and spiders were caught in sufficient numbers to warrant detailed study. Ants were the most active element of the fauna in bush plots during the first two growing seasons, accounting for 42 % of the total catch. Spiders (10 %) formed an important predatory component while crickets (9 %) were the most abundant herbivores and detritivores. Although millipedes were caught in relatively low numbers they were included in the detailed analysis since their importance depends more on their total biomass than on abundance.

Identification of crickets was difficult due to the high proportion of immatures (up to 70 %), though the adults of five families were recorded: Gryllidae (including Gryllinae and Nemobiinae), Mogoplistidae, Trigonidae, Eneopteridae and Phalangopsidae. The latter three families were never caught in large numbers. These are more frequently found on vegetation and thus may have been less susceptible to trapping. Formicidae were represented by six subfamilies: Dorylinae, Ponerinae, Dolichoderinae, Formicinae, Myrmicinae and Pseudomyrmecinae. Pseudomyrmecinae were almost exclusively caught in bush plots and in such small numbers that they have been excluded from further detailed analysis of the population data. Spiders constituted one of the most diverse groups and 24 families were recorded from pitfall traps in bush plots, of which those most commonly caught were the Lycosidae, Linyphiidae, Gnaphosidae and Salticidae. Millipedes were represented by ten families in bush plots but only three, Paradoxamatidae, Trichopolydesmidae and Odontopigidae, were caught in appreciable numbers in cultivated plots.

Clearing and cultivation resulted in a substantial reduction in the activity of the majority of the surface active fauna with catches from the cultivated plots in May 1973 50–60 % below those for bush plots and remaining at a lower level throughout most of the first growing season (Figs. 1a–d).

Crickets and millipedes showed seasonal peaks of activity, populations in both bush and cultivated plots being more active during the rains than in the dry season (Figs. 1a and d).

Table 2. Mean population densities of Acari and Collembola over the period May 1973 to March 1974 for the 0–50 mm soil horizon and September 1973 to March 1974 for the 50–100 mm depth (number m⁻² ± standard error)

Depth		Bush		Cultivated	
0–50 mm	Acari				
	Cryptostigmata	17,403 ±	749	1,991 ±	239
	Prostigmata	8,477 ±	358	9,839 ±	919
	Mesostigmata	3,557 ±	920	1,121 ±	246
	Astigmata	1,372 ±	359	708 ±	216
	Collembola				
	Isotomidae	6,963 ±	900	1,425 ±	366
	Entomobryidae	2,421 ±	213	754 ±	288
	Onychiuridae	1,628 ±	129	243 ±	72
	Sminthuridae	1,128 ±	190	620 ±	23
	Poduridae	665 ±	142	54 ±	11
50–100 mm	Acari				
	Cryptostigmata	7,695 ±	610	2,230 ±	358
	Prostigmata	6,353 ±	580	7,862 ±	2,023
	Mesostigmata	1,013 ±	248	766 ±	363
	Astigmata	237 ±	188	17 ±	10
	Collembola				
	Isotomidae	3,644 ±	1,069	733 ±	192
	Entomobryidae	355 ±	68	425 ±	168
	Onychiuridae	364 ±	57	105 ±	29
	Sminthuridae	280 ±	21	322 ±	16
	Poduridae	200 ±	25	9 ±	6

The overall activity of crickets in bush plots was higher and more prolonged than in cultivated plots, extending further into the dry season and building up with the onset of the early rains in 1974. In cultivated plots activity remained low after the dry season and increased slowly to a level approaching that of the bush plots by the end of the second growing season. Taking the mean number of crickets trapped per plot over the period of observation as an index of activity clear differences emerge between the two habitats (Fig. 2a), the most striking of which is a reduction in the number of immature insects trapped in cultivated plots ($p < 0.001$). Significantly fewer adult Nemobiinae and Mogoplistidae were also trapped in this habitat ($p < 0.01$) though the larger adult Gryllinae were unaffected.

In 1973 few millipedes were trapped in either habitat, though catches in bush plots were consistently higher than those from cultivated plots and this differential increased in 1974 (Fig. 1d). As with crickets, the level of activity increased more rapidly at the onset of the early rains. Occasionally, very large numbers were trapped in both bush and cultivated plots, associated with mass hatching and migration of species such as *Xanthodesmus falcatus* Cook.

No well marked seasonal trends were evident in ant or spider activity (Figs. 1b and c), the numbers trapped in bush plots tending to decline slightly over the two years. Activity of ants in the cultivated habitat increased dramatically by the end of season 73/2 and then fell to a similar, though consistently slightly higher, level than that in bush plots. Spiders responded in a similar manner, their activity being higher in the cultivated plots towards the end of the first growing season and then showing little difference between treatments until the same period in 1974, after which numbers trapped remained higher in cultivated than in bush plots. The peaks of activity in July of each year were due to two different species of the genus *Pardosa* (Lycosidae). The principal effect on the spider fauna was a marked increase in lycosid activity in cultivated plots ($p < 0.01$), whilst catches of other families were generally reduced (Fig. 2b). No significant differences could be detected in the activities of any of the ant subfamilies between the two habitats though the Dorylinae and Formicinae both showed a significantly higher rate of increase ($p < 0.05$) in cultivated plots compared to bush plots. Dorylinae are characteristically nomadic in habit, their presence in plots varying from

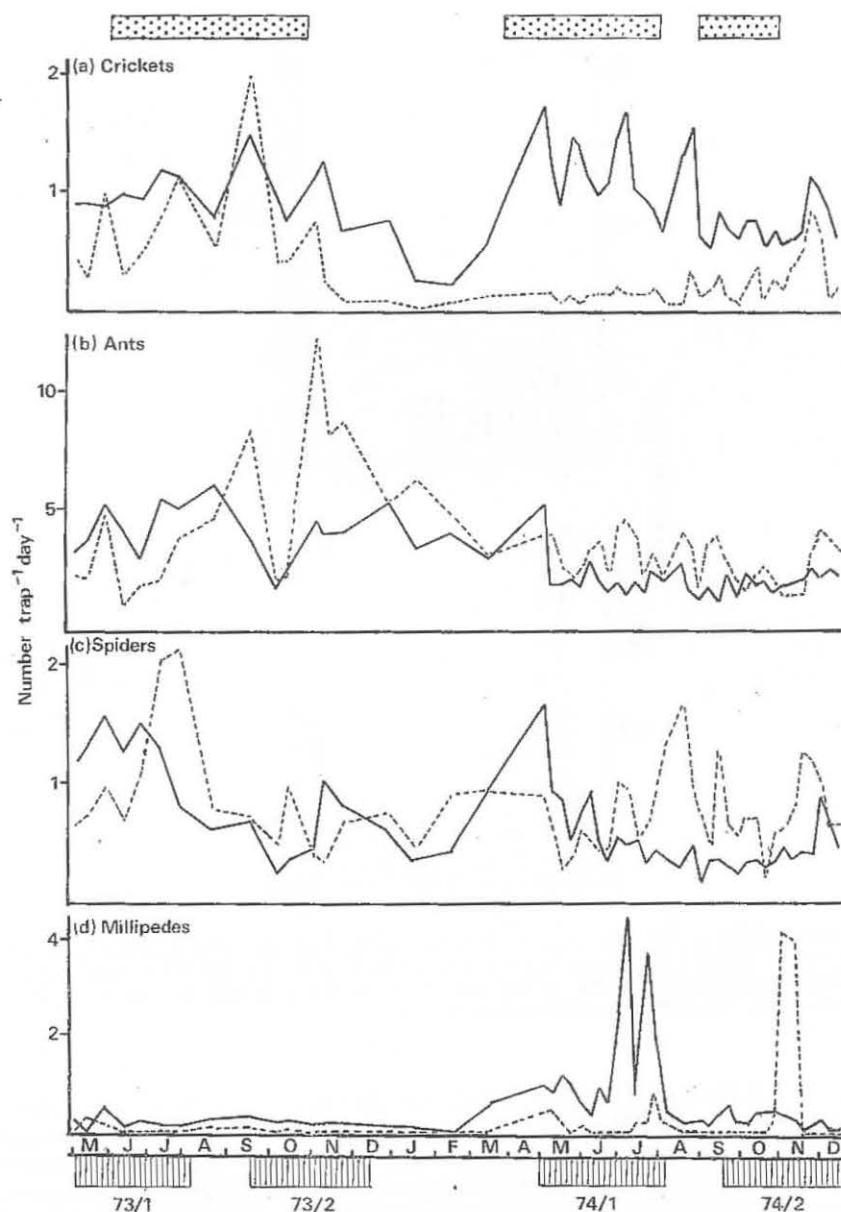


Fig. 1. Seasonal activity of the major groups of the surface active fauna in bush (—) and cultivated (-----) habitats. ■ rainfall over 100 mm per month; ▨ growing seasons.

week to week or month to month depending on whether they are in a stationary or migratory phase (SCHNEIRLA 1971). Formicinae were well represented in cultivated plots, especially by *Acantholepis* spp. and *Camponotus* spp. which nested in fairly open ground and their activity tended to increase as the crop growing season progressed.

3.2. Subterranean fauna

Numbers of microarthropods in the pre-clearing samples taken during the dry season were low, with populations of only 11300 m^{-2} , the Acari being the dominant group and

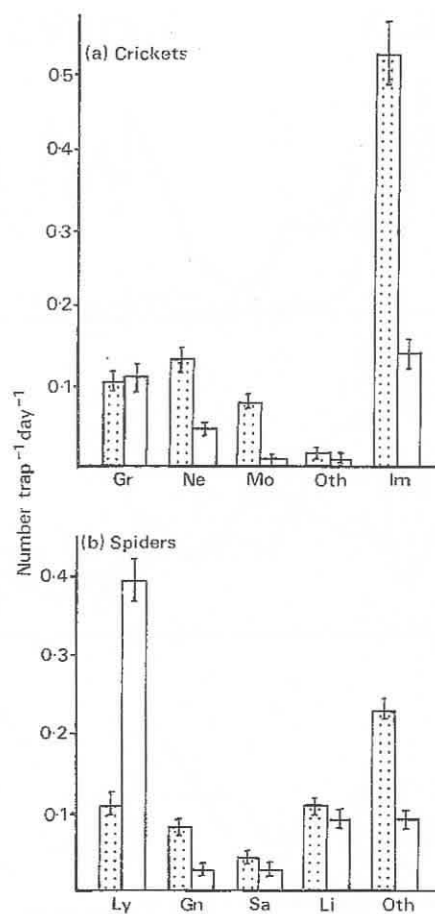
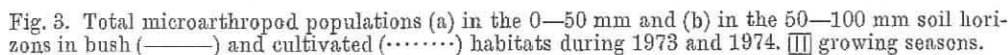


Fig. 2. Relative activity of the dominant cricket and spider families in bush  and cultivated  habitats assessed by pitfall trapping during 1973 and 1974. Gr Gryllinae (Grillidae); Ne Nemobiinae (Gryllidae); Mo Mogoplistidae; Oth others; Im immatures; Ly Lycosidae; Gn Gnaphosidae; Sa Salticidae; Li Liniphiidae. Standard errors are indicated.

constituting 70% of the fauna. Cryptostigmata were the most abundant mites at 4700 m^{-2} followed by Prostigmata at $2,300 \text{ m}^{-2}$. The five major families of Collembola, the Poduridae, Onychiuridae, Isotomidae, Entomobryidae and Sminthuridae, were all present in very low numbers, the total Collembolan population being only $1,200 \text{ m}^{-2}$. Myriapoda were virtually absent and pterygote Insecta poorly represented. No significant differences in microarthropod populations could be demonstrated between the four sampling areas for any of the groups recorded.

The post-clearing sample in March 1973 was the first occasion on which cores were taken from the definitive plots and provided an opportunity to test whether any population differences existed between the designated treatments prior to cultivation. Total populations had risen to $24,000 \text{ m}^{-2}$, largely due to increased numbers of Prostigmata and Collembola, though there were no significant differences between the cleared plots and the uncleared bush plots, or between any of the designated cultivated treatments. Soil disturbance due to cultivation caused substantial changes in the subterranean fauna and prior to planting the first crop of cowpea, populations of microarthropods in the top 50 mm layer of cultivated soil were significantly lower than in bush soils ($p < 0.001$), $12,000 \text{ m}^{-2}$ compared with $59,400 \text{ m}^{-2}$.



Mean population densities of the major groups of Acari and Collembola are shown in Table 2 for both sampling depths. The principal effect in the 0-50 mm horizon was a reduction in numbers of individuals of all groups in cultivated soil with the exception of the Prostigmata, which became the dominant microarthropod group in this habitat. At the lower

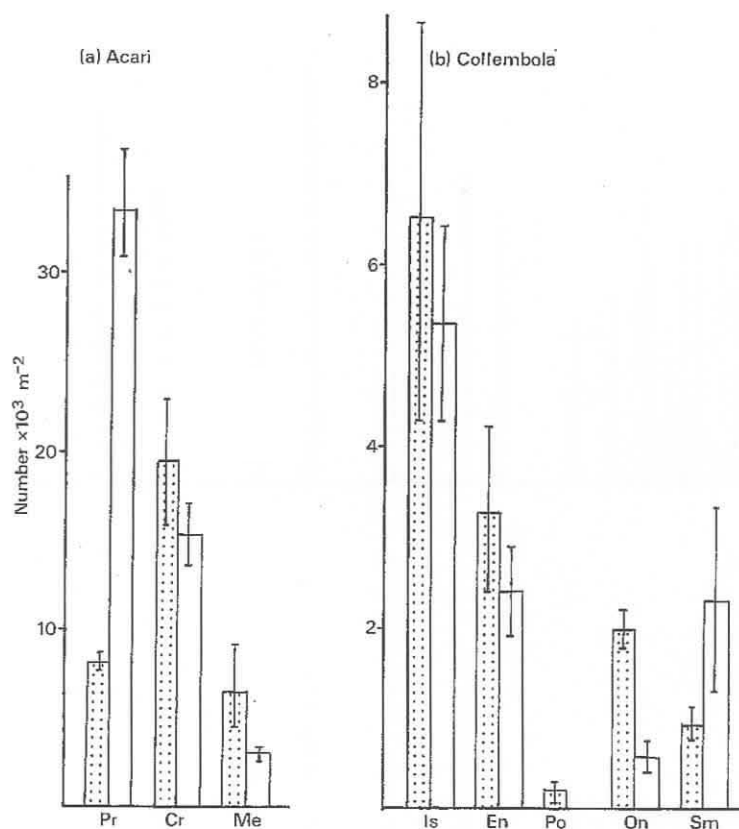


Fig. 4. Population densities of Acari and Collembola in the surface 50 mm of bush $\square$ and cultivated $\square$ soils for a single sampling occasion 17 months after clearing. Pr Prostigmata; Cr Cryptostigmata; Me Mesostigmata; Is Isotomidae; En Entomobryidae; Po Poduridae; On Onychiuridae; sm Sminthuridae.

depth Prostigmata population levels were similar in the two treatments, though the other groups of Acari were reduced in the cultivated soil. Of the Collembola, the Isotomidae, Poduridae and Onychiuridae were present in fewer numbers at the lower depth in the cultivated soil than in the bush soil. When soil cores were taken in July 1974 a striking increase in numbers had occurred in the cultivated plots, more microarthropods being found at both depths than in bush soils. This change was due primarily to an increase in prostigmatid and cryptostigmatid mites and in isotomid Collembola ($p < 0.05$) (Fig. 4). This increase coincided with a period of high rainfall at the end of the first growing season and, as in 1973, numbers of microarthropods fell during the second growing season to $4,300 \text{ m}^{-2}$ in the 0–100 mm horizon in November 1974.

Termites form a significant component of the mesofauna in many tropical forest and savannah soils. In the locality studied they were represented by thirteen species of the family Termitidae. Most of the differences in species composition between the two habitats could be related primarily to bush clearing rather than soil cultivation since the majority of species recorded were either tree-nesting and decomposing wood-feeding, e.g. *Microceratotermes* sp., *Nasutitermes* sp., or were soil-nesting but still very much dependent on wood or litter-feeding, e.g. *Macrotermes bellicosus* (Smeathman) and *M. subhyalinus* (Rambur), *Microtermes* sp., *Ancistrotermes* sp., and *Pseudacanthotermes* sp. Nevertheless, some subterranean soil-feeding termites, e.g. *Pericapritermes* sp., *Adaiaphrotermes* sp., *Anenteotermes* sp., *Astalotermes*

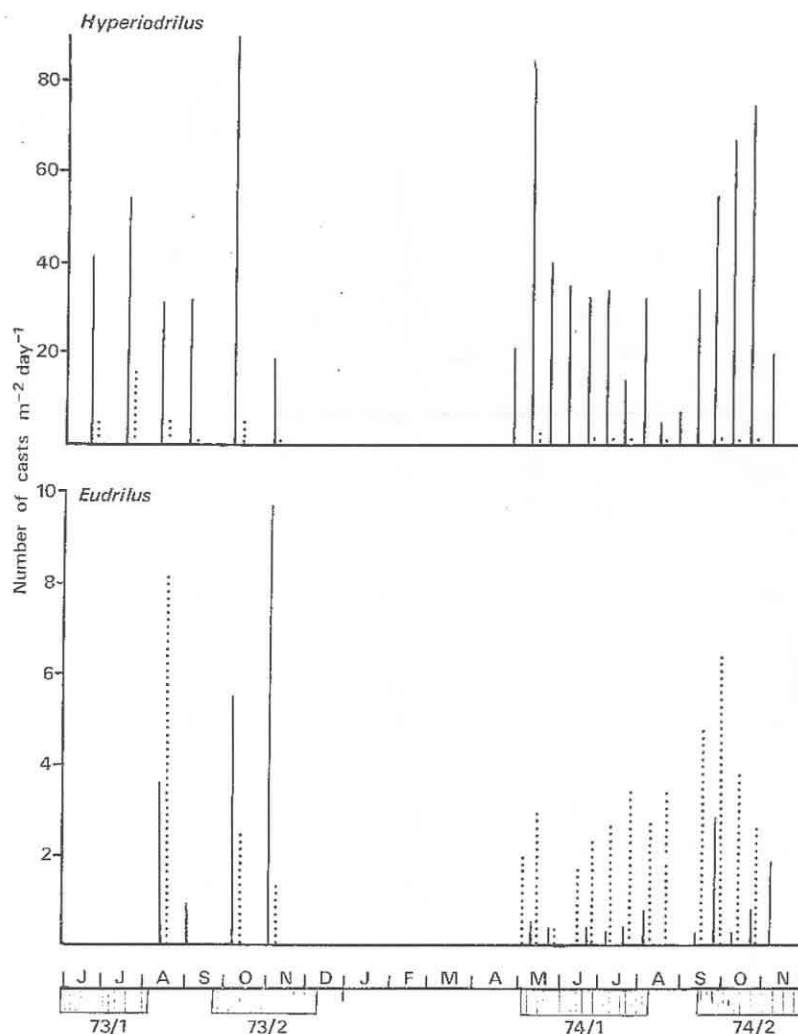


Fig. 5. Casting activity of *Hyperiodrilus* and *Eudrilus* in bush (—) and cultivated (.....) soils. growing seasons.

sp. and *Basidentitermes* sp., were present in bush but not in cultivated soils and may have been eliminated as a result of soil disturbance. Only three species were recorded from cultivated soils. These were *Ancistrotermes* sp., the most frequently recorded species from either habitat, *Acanthotermes acanthothorax* Sjöstedtii, a subterranean fungus-feeder, and *Amitermes* sp., a single mound of which was found at the edge of one of the cultivated plots. The latter two were not recorded from bush plots. Sampling from bush regrowth close to the experimental plots revealed the presence of six other species: *Protermes* sp., *Sphaerotermes* sp., *Trinervitermes* sp., *Eutermellus* sp. and *Pericapritermes* sp.

Earthworms were the most abundant invertebrate macrofauna in bush soils. Four species were identified from bush plot soils: *Dichogaster* sp. and *Millsonia* sp. (Acanthodrilidae) and *Hyperiodrilus* sp. and *Eudrilus* sp. (Eudrilidae). The following species were also identified from adjacent areas: *Alma* sp. (Glossescolecidae), *Benhamia* sp. (Acanthodrilidae), *Heliodrilus lagosensis* BEDDARD, *Eudrilus pallidus* Michaelson and *Legonea* sp. (Eudrilidae). Identification of species in the field was not attempted and casts were categorised as described earlier.

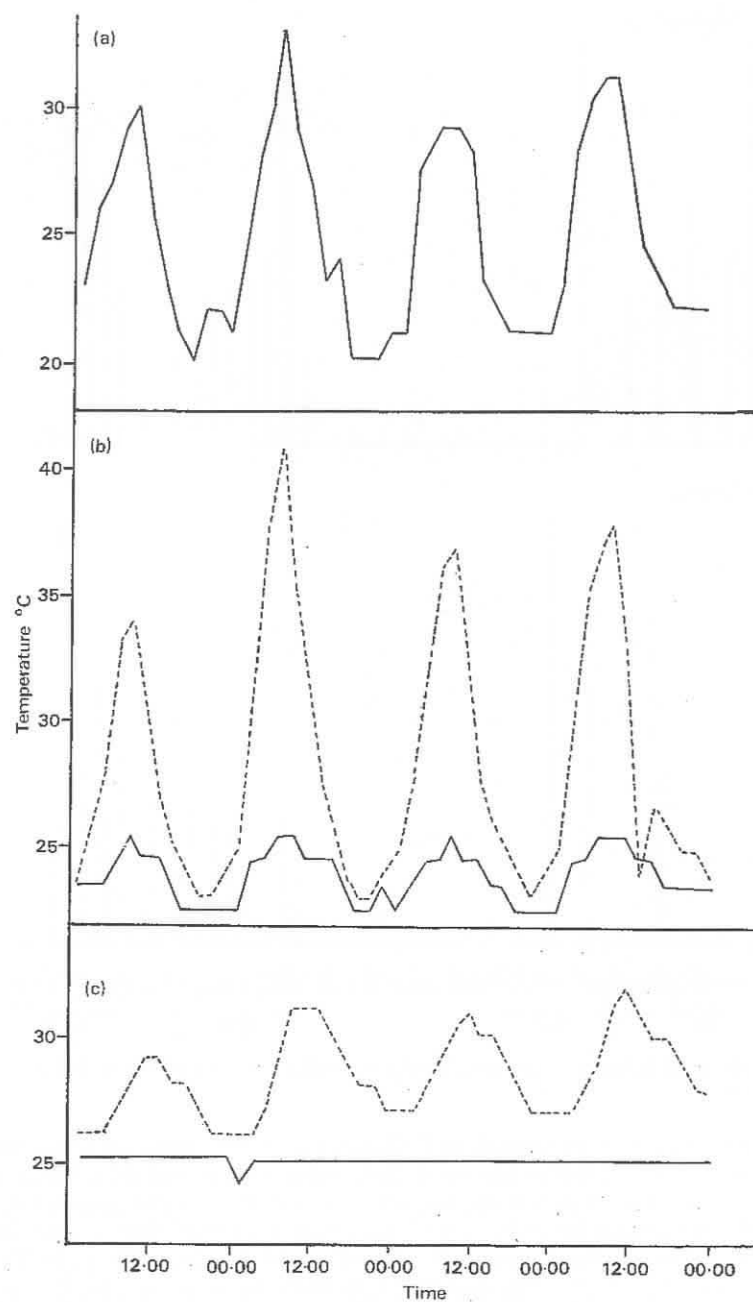


Fig. 6. Temperature recordings from a representative four day period in August 1974; (a) air temperatures 50 cm above the soil surface in both bush and cultivated plots; (b) temperature at the soil surface in a cultivated (.....) and bush (—) plot; (c) temperature 10 cm below the soil surface in a cultivated (-----) and bush (—) plot.

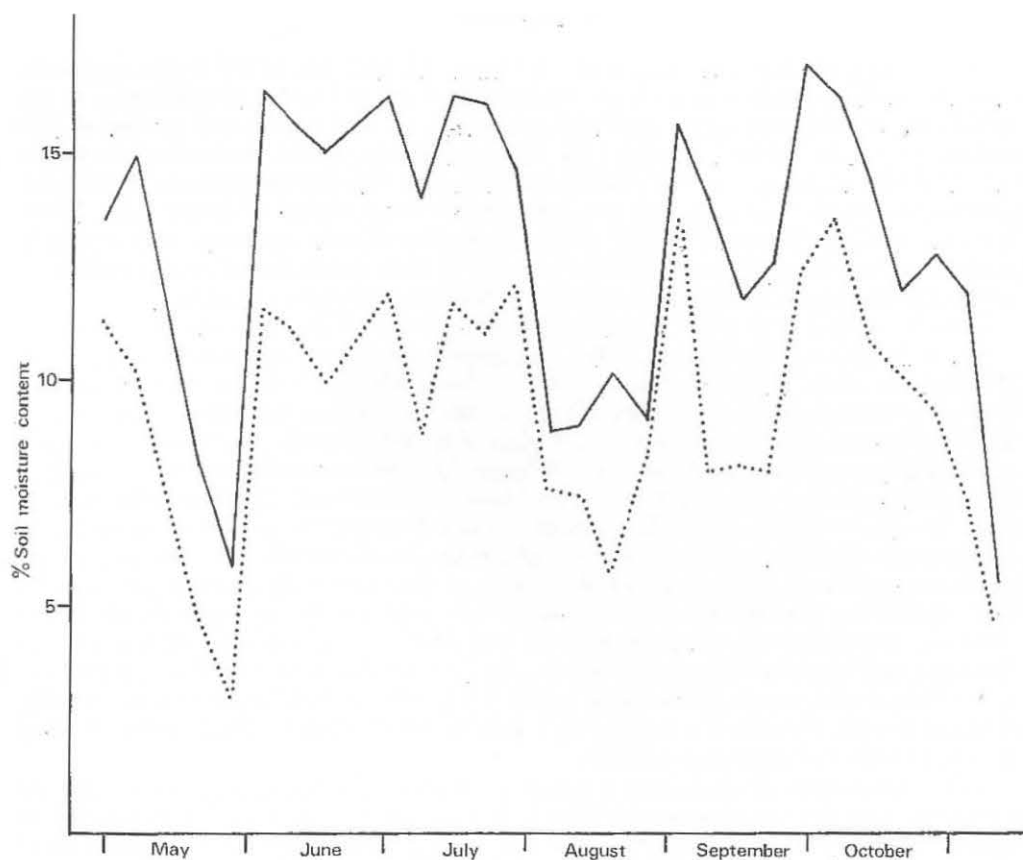


Fig. 7. Percentage water content in cultivated (.....) and bush (—) plot soils from April to November 1974.

Earthworm casts in bush plots were almost entirely attributable to the activities of *Hyperiodrilus* which produced on average about nine times more casts per unit area than did *Eudrilus*. In newly cultivated soils the casting activity of *Hyperiodrilus* was also greater than that of *Eudrilus*. Cast production by the former was largely confined to the area immediately below the crop canopy and reached its peak at maximum crop growth in both growing seasons (Fig. 5). Casting activity of both species ceased in bush and cultivated treatments during the dry season but with the arrival of the rains in 1974 the surface casts of *Eudrilus* became more common in cultivated plots and by the end of the wet season outnumbered those of *Hyperiodrilus* by approximately 7 to 1.

Temperature data for a representative four day period in August 1974 are shown in Fig. 6. The buffering effect of bush vegetation on temperature fluctuations is clearly shown. In the cultivated plot at a depth of 10 cm a diurnal range of temperature between 26–32 °C occurred compared with the bush soil at the same depth where the temperature was almost constant over the four days. Air temperatures were the same in both habitats and soil surface temperatures showed more extreme fluctuations from 23–41 °C in the cultivated plot compared with 23–36 °C in the bush plot. Soil moisture data from April to November 1974 are shown for the 0–12 cm depth in Fig. 7. Bush soils had a consistently higher soil moisture content than the cultivated soils throughout the period. Soil moisture content for the 12 to 24 cm depths were similar in both treatments.

4. Discussion

The clearing of forest vegetation and cultivation of land in the humid tropics represents a drastic environmental change for all components of the soil fauna. Simplification of the habitat occurs with consequent reduction in diversity of food sources and nesting or oviposition sites. The buffering provided by dense vegetation against fluctuations in microclimate is lost, resulting in a much harsher environment with greater extremes of soil temperature, moisture, high insolation and exposure to direct impact of heavy rains. These changes are likely to have a greater effect on smaller, delicate organisms with a limited foraging range and cryptozoic habits than on larger or more mobile animals with omnivorous or carnivorous feeding habits which are less restricted in movement or habits.

Data for surface active fauna are based entirely on pitfall trapping and must be interpreted with caution, particularly where comparisons of contrasting habitats are involved (GREENSLADE 1964). Trapping efficiency will inevitably differ for bush and cultivated plots. Although conditions in the immediate vicinity of the traps were maintained comparable by clearing the surrounding soil surface in bush plots, it is likely that this cleared area may have served as a deterrent to some elements of the fauna. Cryptozoic animals would be particularly affected and it is likely that catches of such animals underestimated their activity in bush plots. Among the surface active fauna small crickets belonging to the family Nemobiinae, wingless mogoplistids, immature crickets of all families, burrowing millipedes such as odontopigids and spiders which depend on web-building or concealment for catching prey were all more affected by clearing and cultivation than were large crickets belonging to the family Gryllinae, non-burrowing millipedes such as polydesmids and ants and spiders such as Dorylinae and Lycosidae respectively which actively hunt their prey. The size and mobility of these larger surface active arthropods was such that their normal foraging range probably extended beyond the area of a single plot, a possible explanation for their similar levels of activity in bush and cultivated habitats.

The overall effect of cultivation is adverse, insofar as the majority of detritivores are concerned, with the concomitant reduction in the amount of surface litter and decrease in habitat stability. However, the introduction of a crop provides a food source for a wide range of insect pests, and predators capable of exploiting this resource might be expected to be favoured. This may explain the increase in numbers of lycosids trapped in cultivated plots. Gnaphosids, conopids and lynphiids were not as successful in colonising the cultivated habitat, being much less mobile and more dependent on concealment or web-building.

For surface active fauna, organisms with sufficient mobility or flexibility in habitat requirements are able to overcome the changes associated with cultivation and even profit from the new situation. In the case of subterranean fauna mobility is far less significant and the ability to withstand the severe habitat disturbance caused by ploughing and increased fluctuation in soil microclimate becomes more important. An examination of the data presented suggests that the latter is the more important in determining abundance after the initial crash in all elements of the fauna, since where microclimatic conditions are least likely to vary between the two habitats populations are similar. Thus at the 50–100 mm depth mean populations of microarthropods show no overall significant differences despite the periodic disturbances caused by ploughing. In the surface horizon, where the impact of climatic variation is maximal, numbers are very similar in July of each year. This is a period with high rainfall and low insolation where the crop canopy is also best developed and providing maximum protection to the soil surface. Towards the end of the rains in the second growing season, conditions become increasingly dry and higher radiation causes elevated temperatures in the upper soil horizon. At this time of year the crop does not provide a buffering effect comparable with that of the bush vegetation and populations decrease, rising again with the start of the following rainy season. The relatively small impact of ploughing is shown by the fact that the population at 0–50 mm increases slightly from the pre-ploughing sample in March to the post-ploughing sample in April and is substantially higher relative to the changes occurring over the same period in bush plots. The increase may be partly explained

by vertical migration associated with improved soil conditions in the upper layer since populations at the 50–100 mm declined over the same interval. Responses to microclimate were also indicated by the more pronounced fluctuations in abundance in cultivated plots. In bush plots the pattern of population build-up was quite different, appearing to follow the litter standing crop which peaks in February and March of each year and declines during the wet season (SWIFT et al. in prep.). This may also be a factor in cultivated plots as the crop senesces very rapidly at maturity, which occurs shortly after maximum vegetative growth, enhancing the July peak.

Within the microarthropods considerable simplification of the fauna was observed in association with cultivation, groups other than Acari and Collembola being virtually eliminated. Both Acari and Collembola increased in numbers after clearing to levels close to those in bush soils but in each case the composition of the fauna was altered. The dominant group of mites in bush soils was the Cryptostigmata, a group containing the majority of larger detritus-feeding forms (WALLWORK 1976) often active within the surface litter layer and likely to suffer most from its removal. In cultivated soils Prostigmata were the most abundant, particularly small forms such as the Pyemotidae, which are well able to penetrate the reduced pore spaces in cultivated soil and which probably feed on organic matter at a more advanced stage of decomposition or associated fungal growth (WALLWORK 1967), and are therefore less affected by the absence of a well defined litter layer. Amongst the Collembola Isotomidae were dominant in both situations and the mainly subterranean Poduridae constituted a much smaller proportion of the fauna in cultivated than in bush soils. LASEBIKAN (1975), in a study which also compared the effects of soil clearing on microarthropod populations of forest soil in Nigeria, found similar effects on Acari ten months after clearing, with Prostigmata increasing in numbers in cultivated soils though not exceeding populations in soil remaining under bush fallow. The same author observed an increase in Poduridae associated with cultivation, unlike the situation in the present work where isotomids were the only collembolans found in numbers in cultivated soil.

The low numbers of termites at the experimental site were probably associated with the shallow nature of the topsoil and relatively poor drainage due to the presence of a laterite layer (PERFECT et al. in prep.) and most of the soil redistribution in bush plots was accomplished by earthworms. Cultivated plots showed rather different characteristics, as judged by cast production, with casting activity attributed to *Hyperiodrilus* declining substantially in the first year and maintained at a very low level in 1974. *Eudrilus* casts increased and were much more common in cultivated than bush plots. These changes are probably associated with the greater tolerance to low moisture and high temperature conditions shown by *Eudrilus* (MADGE 1969). The reduction in surface casting does not necessarily imply lower populations since subsequent data obtained have shown very similar levels of abundance in cultivated plots with extreme differences in cast production (COOK et al. in prep.). The transformation of bush fallow into cultivated land thus has both qualitative and quantitative effects on the soil invertebrate fauna. Subsequent papers will deal with aspects of this phenomenon in greater depth and with its implications for the process of organic matter decomposition and nutrient balance in humid tropical soils under cultivation.

5. Acknowledgements

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6. Summary

The soil fauna of bush regrowth in Ibadan, Nigeria, and the changes which resulted from bush clearing followed by cultivation over a period of two years are described.

Clearing and cultivation were shown to have a considerable influence on numerical abundance and family or species composition of all elements of the fauna. Initial effects are attributed to physical disturbances and later effects to the harsher environment caused by reduced shading and food resources, extremes in soil moisture and temperature and greater soil compaction.

Recolonisation of cultivated soils by some elements of the fauna is dependent on their mobility and burrowing capabilities and ability to withstand the greater fluctuations in microclimatic conditions.

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